Regulative recovery in the sea urchin embryo and the stabilizing role of fail-safe gene network wiring.

Journal: Proc Natl Acad Sci U S A

Publication Year: 2009

Authors: Joel Smith, Eric H Davidson

PubMed link: 19822764

Funding Grants: Training in Stem Cell Biology at CIT

Public Summary:
The “identity” of any cell – how it behaves, the functions it serves – is determined by the combination of a vast number of genes that are actively expressed in that cell. The actual process by which a cell gains its identity, called “specification”, is similarly complex, involving many dozens or hundreds of genes. Specification also involves many “noisy” events, yet given the huge number of possibilities for mistakes to happen it is striking how highly reliable the process is at producing reproducible outcomes. We identified the network of regulatory interactions conferring reliability using the sea urchin embryo as a model. The process of regeneration must also involve highly robust mechanisms to respond to injury and to repair functional tissues. In the absence of reliable mechanisms, regeneration could instead become detrimental to the organism. This may underly the inability of some animals to regnerate complex tissues. Thus, the ability to identify the regulatory interactions conferring network reliability can be important to studies of regeneration in tissue that do not normally repair and regrow.

Scientific Abstract:
Design features that ensure reproducible and invariant embryonic processes are major characteristics of current gene regulatory network models. New cis-regulatory studies on a gene regulatory network subcircuit activated early in the development of the sea urchin embryo reveal a sequence of encoded "fail-safe" regulatory devices. These ensure the maintenance of fate separation between skeletogenic and nonskeletogenic mesoderm lineages. An unexpected consequence of the network design revealed in the course of these experiments is that it enables the embryo to "recover" from regulatory interference that has catastrophic effects if this feature is disarmed. A reengineered regulatory system inserted into the embryo was used to prove how this system operates in vivo. Genomically encoded backup control circuitry thus provides the mechanism underlying a specific example of the regulative development for which the sea urchin embryo has long been famous.

PNAS Lens Free Article Link: